namic data acquisition, ensuring that the needed information is obtained at peak stimulation.

Arteriography is done only if reconstructive surgery is contemplated. The examination includes subselective catheterization of the internal pudendal arteries, magnification technique, and evaluation of the recurrent epigastric arteries, which will be harvested for revascularization. An arterial operation is usually successful in younger patients with perineal trauma with a single point of stenosis or occlusion but has been least successful in those patients with atherosclerosis because of the multifocal nature of this disease.

Diagnostic information available today is more specific and reliable than at any time in the past and can realistically estimate the severity of the hemodynamic disorder and allow individual treatment options. Ongoing studies will show whether the data these studies provide make an important difference in the treatment of vascular impotence.

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Current Status of Discography

DISCOGRAPHY IS A physiologic evaluation of intervertebral discs consisting of volumetric, manometric, pain provocative, and radiographic appearance. Since its introduction in 1948, discography has gained and lost popularity several times. It suffered a major setback in 1968, after reports of 37% false-positive results in normal volunteers. The literature is still replete with articles that have reported its many advantages and applications and have considered it an essential guide to planning operations on the spine.

The procedure consists of injecting contrast material under fluoroscopic control via an extradural or intradural approach. The injection in a normal disc is painless—the patient feels only a pressure sensation—and the contrast agent remains in the nucleus pulposus. The test result typically is considered positive when injection creates pain that simulates the patient's symptoms and is associated with an abnormal morphologic discogram appearance or contrast extravasation, or both. An 89% parallel correlation of magnetic resonance imaging and discography has been reported.

Discography is indicated when magnetic resonance imaging, computed tomography, or a myelogram shows negative or equivocal findings for disc disease; when there is a positive result on these tests indicating disc disease at multiple levels—in this case, discograms are used to determine the symptomatic level or levels; in the case of recurrent low back pain after a surgical procedure to distinguish scar tissue from recurrent disc herniation; to evaluate the discs above or below the proposed spinal fusion; and as a test for an injection of cortisone.

Although discography is a relatively safe procedure, a discitis rate of 1% to 4% has been reported. Allergic reactions to nonionic contrast agents are uncommon, and epidural abscess is extremely rare. The total cost for a three-disc-level procedure is currently between $1,000 and $2,000, including professional and hospital fees. Despite the clouds of controversy surrounding discography, it remains the only provocative test available and is indicated as a complementary test before a surgical procedure is done on the spine.

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Radiosurgery for Tumors and Arteriovenous Malformations of the Brain

TUMORS AND ARTERIOVENOUS MALFORMATIONS located in deep, inaccessible areas of the brain are now treatable with radiosurgery, a technique that uses high doses of radiation to inactivate these lesions. Several different methods of radiosurgery have been developed, but all share the common characteristic of focusing multiple, precise, small radiation beams on an intracranial target. Although charged particle beams have been successfully developed for radiosurgery, the most widely available devices use photon radiation generated by a linear accelerator or a multiple cobalt 60 source machine ("Gamma Knife").

Radiosurgery is given in a single or a very small number of treatments, unlike conventional radiotherapy in which multiple fractions are delivered over a period of weeks. To do radiosurgery, a stereotactic localization device is fixed to the patient's skull; this apparatus provides a coordinate system for defining the position of the lesion and its relationship to surrounding brain structures. Computed tomography scans are done to determine the three-dimensional configuration of the lesion; angiography and magnetic resonance scans may also be useful. Computed radiation treatment planning is used to design radiation dose distributions that conform to the shape of the target, confining the areas of high dosage to the lesion, with less irradiation of surrounding brain tissue. Radiosurgery is done—usually on an outpatient basis—with the patient's head immobilized in the localization device.

Excellent results have been obtained using radiosurgery for patients with inoperable arteriovenous malformations. Most treated with radiosurgery—60% to 90%—are completely obliterated as documented by follow-up angiography. The risk of cerebral hemorrhage is eliminated provided the malformation is totally obliterated. Regression of the lesion is slow after radiosurgery, however, taking one to three years to complete. The risk of bleeding persists during the interval between treatment and complete obliteration. Radiosurgery can be used as the sole modality to treat small arteriovenous malformations—less than 3 cm—or can be combined with angiographic embolization for more extensive lesions.

A variety of benign and malignant brain tumors have been treated with radiosurgery, including acoustic neuromas, meningiomas, pineal and pituitary region tumors, gliomas, posterior fossa neoplasms and metastatic lesions. For selected small, noninvasive tumors, radiosurgery alone may be used, while for larger neoplasms, surgical debulking can be ini-

tially used, followed by radiosurgery to treat the residual tumor. Radiosurgery is particularly useful for tumors that have recurred after a surgical procedure and conventional radiation therapy, provided the volume of recurrent disease is small.

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Chemoembolization in the Treatment of Hepatic Malignancy

UNRESECTABLE HEPATIC MALIGNANCY, either primary or metastatic, carries a grave prognosis, with a usual life expectancy of three months to six months, and, unfortunately, the condition is common. Colon carcinoma, which frequently spreads to the liver, will take 60,000 American lives every year. Hepatocellular carcinoma (HCC), the most common fatal malignancy worldwide, is endemic in the Orient. With Pacific Rim migration, the incidence is expected to increase in the western United States. Response rates with systemic chemotherapy are about 30% and, in hepatic metastases caused by colon carcinoma, about 20%.

The poor prognosis and high prevalence have led to innovative treatments of liver tumors, including infusing chemotherapy directly into the hepatic artery (to increase the concentration delivered to the tumor) and blocking the blood supply with microscopic particles (to cause tumor ischemia). Chemoembolization is a combination of the two therapies in which chemotherapy and particles are infused simultaneously.

Three congruent circumstances permit the safe and effective application of such regional treatments: the liver has a dual blood supply with either the hepatic artery or portal vein capable of sustaining the organ; tumors of the liver are supplied by the hepatic artery; and the hepatic artery is nearly always accessible percutaneously with current catheterization techniques.

Patients eligible for chemoembolization include those in whom the tumor is unresectable yet confined to the liver. Initially, angiography of the celiac axis and superior mesenteric artery are done to determine the blood supply of the liver and status of the portal vein. A small (2F to 3F) catheter is placed coaxially through the larger (5F to 6F) guiding catheter past the intestinal and gallbladder vessels into the hepatic artery. The chemoembolization mixture is infused while monitored by fluoroscopy. Nausea and pain after the procedure are greatly relieved by the antiemetic ondansetron and intra-arterial lidocaine, respectively. Complications such as embolization of the intestine, hepatic abscess, or infarction occur in less than 3% of patients. Response rates in hepatocellular carcinoma have ranged from 50% to 75%. In addition, most recent studies have involved patients who failed to respond to systemic chemotherapy.

Newer applications and broader use of hepatic chemoembolization are expected. Such advances may include the shrinkage of hepatic malignancies permitting curative resection, palliation until liver transplantation, safe use in patients with portal vein thrombosis, and the application in children with hepatoblastoma and hepatocellular carcinoma.

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Vasodilator and Exercise Cardiac Perfusion Scintigraphy

THE LONG ANTICIPATED Food and Drug Administration approval of two technetium 99m (^{99m}Tc)-based cardiac perfusion imaging agents and the coronary vasodilator dipyridamole for intravenous administration occurred early in 1991.

Dipyridamole increases coronary blood flow without exercise and improves the sensitivity of isotope imaging in those patients unable to exercise well. Side effects such as chest pain, headache, and dizziness are common but reversible with aminophylline.

The two ^{99m}Tc isonitrile agents differ greatly in biodistribution. The ^{99m}Tc-teboroxeme redistributes rapidly from myocardium. This has advantages for rapid sequential stress and rest imaging but demands rapid imaging following exercise. Ideally, the exercise is done in close proximity to a multi-head single photon emission computed tomography (SPECT) system.

The ^{99m}Tc-sestamibi agent remains fixed for hours in the myocardium proportional to regional blood flow at the time of injection. This has distinct logistic advantages. The physical distance of the laboratory from the nuclear medicine site or delays in completing examinations no longer compromise the study as they might with thallium 201 (^{201}Tl). The ^{99m}Tc not only reflects perfusion but also shows myocardial viability better than ^{201}Tl. Areas of ischemia appearing as infarcts are less common.

Both ^{99m}Tc compounds have distinct physical advantages over ^{201}Tl. The 140 kiloelectron volt (keV) photons are less attenuated by tissue and better suited for SPECT imaging than ^{201}Tl (80 keV). The shorter half-life—6 hours versus 73 hours—allows more activity with less radiation absorbed. Initial reports indicate comparable or favorable results compared with ^{201}T1, and further experience is likely to show improved results as the physical advantages are exploited by changing techniques. Cost is comparable and may even be less per study in high-volume departments.

Positron studies have distinct physical advantages over all SPECT agents. With very high-energy (511 keV), short-lived isotopes, attenuation by tissue is minimal and specificity is higher than SPECT. Combined perfusion and glucose metabolism are the gold standard for noninvasive assessment of viability. The high cost and limited availability are major disadvantages.

As the physical advantages of the ^{99m}Tc compounds are exploited to improve the specificity of SPECT imaging, they will have an important effect on the evaluation of coronary